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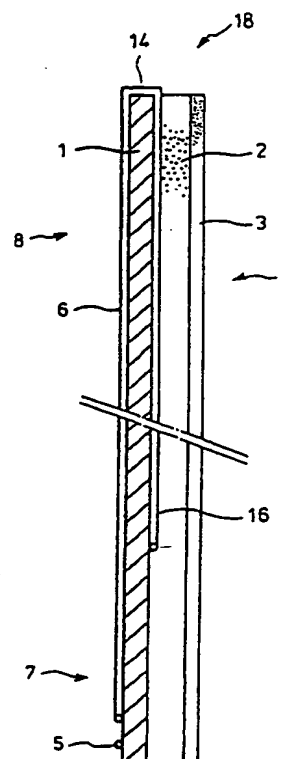
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(54) Heat protection element.

(57) A heat protection element includes an impermeable intermediate layer (1), e.g. of refractory, heat-insulating material, an inner cooling layer (8) with liquid passages (5,6,7) through which, in use, a cooling liquid flows adjacent the inner surface of the intermediate layer, an outer, porous cooling layer (4) adjacent the outer surface of the intermediate layer and pipework (17) communicating with the passages (5,6,7) and arranged to direct the cooling liquid to a plurality of points on the outer porous layer (4).

Fig.3



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The present invention relates to a heat protection or refractory element for fire-proofing or heat-shielding purposes.

It is known that a building or the like may be fire-proofed by using refractory interior and exterior members and/or heat-insulating members between interior and exterior portions of the building.

It is known also to protect products from burning in the event of a fire by covering them with refractory sheets.

The use of such refractory and/or heat-insulating members for fire-proofing buildings is associated with a number of problems:

- (1) When a fire occurs outside a building or the like, the transmission of heat from the exterior to the interior of the building or the like cannot be completely prevented by the refractory and/or heat-insulating members, resulting in rise in temperature in the interior of the building or the like.
- (2) Fabrication of the refractory members and/or heat-insulating members is very time-consuming since they are separate items.

Similarly, whilst covering goods and the like with refractory sheets may prevent them from burning it cannot completely prevent the transmission of heat through the refractory sheets, resulting in degradation of and damage to the goods.

The object of the present invention is to provide a heat protection element which can maintain the temperature at its surface at a predetermined level, even when there is a fire adjacent the outer surface, and which, when in the form of a panel may be very simply fabricated.

According to the present invention a heat protection element is characterised by an impermeable intermediate layer, an inner cooling layer with liquid passages through which, in use, a cooling liquid flows adjacent the inner surface of the intermediate layer, an outer porous cooling layer adjacent the outer surface of the intermediate layer and pipework communicating with the passages and arranged to direct the cooling liquid to the outer porous layer.

In use, a liquid, such as water, flows through the passages in the cooling layer and extracts heat from it. It then passes into a pipework from which it discharges or trickles into the outer porous layer which is thus maintained wet. The liquid may discharge into the porous layer at a single point but it is preferred that this occurs at a plurality of spaced points over the area of the porous layer. Due to the fact that the porous layer is maintained damp it is cooled by the evaporation which occurs caused by the heat incident on it from a fire or other intense heat source. The heat protection element in accordance with the invention thus acts as a thermal barrier and therefore also as a fire protection element.

The intermediate layer may be metallic in which case the liquid passages in the cooling layer will be in

thermal contact with it and extract heat from it. It is however preferred that the intermediate layer is made of refractory, heat-insulating material which may optionally be lined on one or both surfaces with metallic material.

The liquid passages of the cooling layer may constitute the inner surface of the heat protection element or they may be covered by a metallic layer which serves to spread and equalise the thermal load.

The heat protection element in accordance with the invention may be in the form of a rigid panel. The invention also embraces an enclosure, such as a lift or elevator, made of a plurality of such panels and in this event the liquid passages of the cooling layers will be connected either in parallel or in series to a liquid supply.

Alternatively, the element in accordance with the invention may be in the form of a flexible sheet and in this case the sheet may be spread over products or other articles to protect them from degradation in the event of a fire.

Further features and details of the present invention will be apparent from the following description of certain preferred embodiments which is given with reference to the accompanying drawings, in which:

Figure 1 is an inside view of a first embodiment of a heat protection element according to the present invention;

Figure 2 is an outside view thereof;

Figure 3 is a sectional view taken on the line III-III in Figure 1;

Figure 4 is a partially cut-away perspective view of a heat protection chamber formed by heat protection elements of the type shown in Figure 1;

Figure 5 is a sectional view of a heat-resistant, flexible pipe used in the chamber shown in Figure 4;

Figure 6 is a sectional view of a second embodiment of a heat protection element according to the present invention;

Figure 7 is a partially cut-away view illustrating the inside thereof;

Figure 8 is a partially cut-away outside view of the second embodiment shown in Figure 6;

Figure 9 is a sectional view taken on the line XI-XI in Figure 6;

Figure 10 is a perspective view illustrating an elevator constructed from elements as shown in Figure 6;

Figure 11 is a sectional view taken on the line XI-XI in Figure 10;

Figure 12 is a view illustrating an ambulance trailer connected to a heat shielded cable shown in Figure 10;

Figure 13 is a schematic view of an elevator;

Figure 14 is an exploded perspective view illustrating a third embodiment of a heat protection element according to the present invention;

Figure 15 is a scrap sectional view thereof;
Figure 16 is a sectional view of a fourth embodiment of a heat protection element according to the present invention;

Figure 17 is a partially cut-away perspective view of a fifth embodiment of a heat protection element according to the present invention;

Figure 18 is a view illustrating a heat-transmission cooling surface of the fifth embodiment shown in Figure 17;

Figure 19 is a view illustrating the trickle cooling surface of the fifth embodiment shown in Figure 17; and

Figure 20 is a scrap sectional view of the embodiment of Figure 17.

Referring firstly to Figures 1 to 3, an impermeable intermediate layer 1, which is fabricated from metal, such as a sheet of aluminium, stainless steel or the like, has outer and inner surfaces on which are disposed an outer, porous, trickle cooling layer 4 and an inner heat-transmission cooling layer 8.

The outer layer 4 comprises a soft porous member 2 such as a sheet of ceramic paper made of fibrous SiO_2 and a hard porous member 3 such as a reinforced sheet of ceramic paper made of ceramic paper impregnated with silicon.

The inner layer 8 comprises a cooling pipework 7 which extends over substantially the entire area of the intermediate layer 1 and through which, in use, cooling liquid passes. The cooling pipework 7 has a main pipe section 5 extending along the base and along one side of the intermediate layer 1 and two serpentine sections 6 one of whose ends is connected to the main pipe section 5 and which is disposed in a zig-zag configuration on the inner surface of the intermediate layer 1. A cooling liquid supply means 10 in the form of a readily attachable joint or the like is connected to the inlet end 9 of the cooling pipework 7 at the lower end of the main pipe section 5.

A cooling liquid distribution port means 12 in the form of a readily attachable joint or the like complementary to the supply means 10 is attached to the distribution end 11 of the cooling pipework 7 at the upper end of the main pipe section 5.

An extension pipe 14 extends from the downstream end 13 of each serpentine section 6 over the upper side of the intermediate layer 1 to the rear surface thereof.

Each extension pipe 14 is connected to a pipework 17 comprising a plurality of branched pipe sections 16 each having at its downstream end a cooling liquid trickling port 15 which is disposed between the intermediate layer 1 and the porous member 2.

The above refractory element is in the form of a panel 18 and a plurality of such panels 18 are joined to a frame 19 with the heat-transmission cooling layer 8 and the trickle cooling layer 4 being at the inside and outside, respectively, to form a refractory chamber 20,

as illustrated in Figure 4.

As best shown in Figures 4 and 5, a cooling liquid supply pipe 23 made of copper and having openings 22 is spirally wound around a flexible pipe 21, e.g. of stainless, corrugated material and is covered with a permeable refractory cloth 24 such as silica cloth, thereby providing a heat-shielded flexible composite pipe 25. The pipe 25 is connected at its one end to the bottom of the refractory chamber 20, and an electrical cable 26 and a cooling liquid supply pipe 27 which is different to the cooling liquid supply pipe 23, extend through the pipe 25 into the refractory chamber 20.

The supply pipe 27 is connected to the supply port 10 of each refractory panel 18 (in this case, the distribution port 12 of each panel 18 is closed); alternatively, the cooling pipework 7 of each panel 18 is connected in series by connecting the ports 12 and 10 of adjacent panels 18 and the supply pipe 27 is connected to one of the supply port means 10 and only one of the distribution ports 12 is closed.

Reference numeral 28 in Figure 1 denotes a cooling liquid and numeral 29 denotes an inner material covering the inner layer 8 of the panel 18.

The mode of operation of the heat protection panel 18 described above is as follows:

Normally, no cooling liquid 28 flows through the supply pipe 27 within the flexible pipe 25.

In the event of a fire, in response to a fire alarm system, cooling liquid 28 is caused to flow through the supply pipes 23 and 27. Alternatively, this operation may be started manually by a person responsible for fire prevention.

The cooling liquid 28 oozes through the openings 22 of the supply pipe 23 around the flexible pipe 21 and spreads through the permeable refractory cloth 24 by capillary action and wets the whole surface of the refractory cloth 24.

When the wet refractory cloth 24 on the refractory flexible pipe 25 is exposed to fire, the cooling liquid 28 evaporates from the cloth 24 to dissipate the heat received by the cloth 24 as latent heat, whereby the pipe 25 is protected from heat. Cooling liquid 28 is continuously supplied by capillary action to the cloth 24 from which it is evaporating. The refractory cloth 24 can thus be maintained in a constantly wetted state so long as the quantity of cooling liquid flowing through the supply pipe 23 is maintained at a suitable level.

Since the refractory pipe 25 is protected from heat, a stable and dependable supply of cooling liquid 28 to the refractory chamber 20 through the supply pipe 27 is ensured.

The cooling liquid 28 supplied through the supply pipe 27 flows into the supply port 10 of each refractory panel 18. The liquid 28 then flows through the main pipe section 5 and the serpentine pipe sections 16, thereby cooling the inner, heat-transmission cooling layer 8. The temperature is thus maintained at a constant level in the interior of the refractory panels 18

and thus in the refractory chamber 20.

Thereafter, the cooling liquid 28 flows through the extension pipes 14 into the branched pipe sections 16 of the pipeline 17 and then trickles or oozes through the discharge ports 15.

The discharged cooling liquid 28 permeates the porous materials 2 and 3 of the outer layer 4 by capillary action to wet its whole surface.

When the refractory chamber 20 is exposed to external heat, cooling liquid 28 evaporates from the cooling layer 4 to dissipate the heat absorbed by the layer 4 as latent heat of evaporation and thereby prevents transmission of heat from the exterior into the interior of the refractory chamber 20.

Thus in the present invention, after the cooling liquid 28 has been used to cool the inner, heat-transmission cooling layer 8 in the refractory chamber 20, it is used again to cool the outer, trickle cooling layer 4. Therefore, a high degree of cooling efficiency is obtained with a relatively small amount of cooling liquid.

In addition, the outer, intermediate and inner layers 4, 1 and 8 are integrally incorporated in the form of a refractory panel 18, and its fabrication is thus relatively simple.

As described above, the temperature in the refractory chamber 20 can be maintained substantially constant. The refractory chamber 20 is adapted to be used as a shelter or a computer room. In addition, corridors in a building may be lined with such panels 18 so that it may be used as an emergency evacuation route in case of fire.

The second embodiment illustrated in Figures 6 to 12 differs from the first embodiment in that the intermediate layer 1 comprises a refractory member 30 and impermeable members 31 such as a sheet of aluminium or stainless steel, the members 31 being bonded to opposite surfaces of the member 30 to form a sandwich and that the outer, trickle cooling layer 4 comprises a porous member 2 having an outer surface to which an exterior member 34 such as a sheet of stainless steel or a heat-resisting composite member with a large number of pores or small openings 33 is bonded with the interposition of spacers 35 so as to provide vapour passages 36.

In addition, an interior member 29 is preliminarily bonded to the cooling pipework 7.

Such panels 18 may be used to construct, for example, an elevator as shown in Figures 10 to 12.

A vertically extending recess 38 is defined in an outer wall of a high building 37. An emergency elevator body 39 with walls made of or lined with the panels 18 is located within the recess 38 so as to be vertically movable. More specifically, the elevator body 39 is suspended by a wire 42 from an emergency exit room 41 constructed on the top 40 of the building 37.

The wire 42 is securely joined at its upper end to

the upper portion of the exit room 41 while the lower end thereof is wound around the winch drum 44 of a lift apparatus 43 securely connected to the top of the elevator body 39 so that when the wire 42 is wound or unwound by the winch drum 44, the elevator body 39 is lifted or lowered.

The panels 18 are bonded to the elevator body 39 such that the heat-transmission cooling layers 8 define the interior walls of the elevator body 39 while the trickle cooling layers 4 define the exterior walls.

Installed on the top of the elevator body 39 are an emergency air cylinder 45 capable of supplying air into the elevator body 39 and a water supply system or water tank 46 which is normally filled with a predetermined quantity of water and which is connected through valves (not shown) to the cooling pipework 7 of the panels 18 (see Figure 11).

One end of a fire-resistant cable 47, similar to that shown in Figure 5 and extending from the exterior of the building 37, is connected to a predetermined position on the elevator body 39 and a water supply pipe 48 for supplying the water into the water tank 46, an electric power cable 49 for supplying power to the lift system 43 and an air supply pipe 50 for supplying air into the elevator body 39 independently of the air storage cylinder 45 extend through the refractory cable 47 from the exterior of the building 37 into the elevator body 39.

The other end of the cable 47 is connected to, for example, a rescue trailer 51 as shown in Figure 12 which is equipped with a generator, a water pump, an air pump and which is parked near the building 37.

Reference numeral 52 indicates an entrance door; 53, an exit door; and 54, guide rollers for preventing direct contact of the elevator body 39 with the building 37 during lifting or lowering of the body 39.

The mode of operation of the second embodiment is as follows:

Normally, the wire 42 is wound around the winch drum 44 of the lift system 43 to hold the elevator body 39 adjacent the emergency exit room 41. In the event of a fire, evacuees in the building 37 go up to the top 40 of the building 37 and then open the doors 52 and escape into the elevator body 39. Next, the valve of the air storage cylinder 45 is opened to fill the interior of the elevator body 39 with fresh air so that the pressure therein rises slightly in excess of the atmospheric pressure, thereby preventing the intrusion of the smoke into the interior of the elevator body 39. Thereafter, the valve of the water storage cylinder 46 is opened to supply water to the cooling pipework 7 of the panels 18.

The water supplied into the cooling pipework 7 of each panel 18 cools the surface of the heat-transmission cooling layer 8 of the refractory panel 18 or the interior of the elevator body 39 and is introduced into the pipelines 17 and discharged or trickles through the discharge holes 15 so that it permeates into the por-

ous member 2 of the trickle cooling layer 4, thereby wetting it.

On the ground, the other end of the refractory cable 47 is immediately connected to the rescue trailer 51 so as to supply electric power, water and air into the elevator body 39.

When the refractory cable 47 is connected to the rescue trailer 51, the evacuees in the elevator body 39 operate the lift system 43 to lower the elevator body 39. Upon arrival on the ground, they open the exit doors 53 and get out of the elevator body 39.

As in the first embodiment, when the elevator body 39 is exposed to heat from the fire as it is lowered, the water evaporates through the surface of the porous members 2 of the refractory panels 18 to dissipate heat from the trickle cooling layer 4 as latent heat. As a result, penetration of heat from the exterior to the interior of the elevator body 39 is prevented. This effect is further promoted by the refractory intermediate layer 1 inwardly of the outer layer 4.

As described above, the electric power is supplied from the rescue trailer 51 through the heat-resisting cable 47 in the second embodiment. This is because there is a possibility that the electric power source in the building 37 cannot be used. However, a further lift system for winding or rewinding the wire 42 may be disposed on the top of the rescue room 41 to be energised by a power source in the building 37. The lift system 43 and this further lift system may be used alternatively or in combination.

The reason why the air and water are supplied through the refractory cable 47 from the rescue trailer 51 is that if many people are to escape from the building 37, the elevator body 39 must be repeatedly lowered and lifted so that there is a risk of the air and water supplies from the air storage cylinder 45 and the water tank 46 being exhausted. The air and water may be directly supplied to the interior of the elevator body 39 from the rescue trailer 51 without providing the elevator body 39 with the air storage cylinder 45 and the water tank 46. In this case, the water pump on the rescue trailer 51 is used as the water supply to the elevator body 39.

It should be noted that the refractory cable 47 is wound and unwound by a winch drum which has connecting means for the water, electric power and air sources.

Figure 13 illustrates another example of an elevator constructed from panels 18 according to the present invention. In this example, the inner walls of an elevator shaft 55 are constructed or lined with the panels 18 which are connected through a valve 57 to a water storage tank 56 provided on top of the building 37.

Due to the fact that the walls of the elevator shaft 55 are constructed from or lined with the panels 18, a temperature rise in the shaft 55 can be prevented in the event of a fire to further ensure the safety of the

evacuees.

The third embodiment illustrated in Figures 14 and 15 is substantially similar to the first and second embodiments except that the outer, trickle cooling layer 4 comprises the porous member 2, a wire retaining net 58 and a lattice 59.

The fourth embodiment illustrated in Figure 16 is substantially similar to the first, second and third embodiments except that the inner, heat-transmission cooling layer 8 comprises a cooling liquid jacket 63 which has a corrugated plate 60 which defines cooling liquid passages 61 and 62 on both sides of the plate 60 and a plurality of pipes 64 which extend from the jacket 63 through the heat-insulating intermediate layer 1 to the porous member 2 to provide a trickle supply to the member 2 at a plurality of points distributed over its area.

In the fifth embodiment shown in Figures 17 to 20, the heat-resistant element 65 in accordance with the invention is constructed in the form of a blanket.

The intermediate layer 1 comprises a heat-resisting sheet 66 of flexible material, e.g. cloth made of the material sold under the Trade Mark Kevlar, on both surfaces of which aluminium is deposited.

The cooling pipework 7 comprising nylon tubes, Teflon (trade mark) tubes, copper tubes or the like is sewed to the refractory sheet 66 and is covered with an interior member 73 which in turn is made of material substantially similar to that of the heat-resisting sheet 66, which components together constitute the heat-transmission cooling layer 8. The trickle cooling layer 4 comprises porous ceramic paper 67 sandwiched by silica cloth sheets 68 and 69, which are made by weaving silica fibres to form an integrated cloth-like body 70.

Belts 71 and buckles 72 are attached to opposite sides of the refractory blanket 65.

In other respects, the fifth embodiment is substantially similar to the first to the fifth embodiments and also can be used in a similar manner.

Claims

1. A heat protection element characterised by an impermeable intermediate layer (1), an inner cooling layer (8) with liquid passages (5,6,7) through which, in use, a cooling liquid flows adjacent the inner surface of the intermediate layer, an outer, porous cooling layer (4) adjacent the outer surface of the intermediate layer, and pipework (17) communicating with the passages (5,6,7) and arranged to direct the cooling liquid to the outer porous layer (4).
2. An element as claimed in claim 1 characterised in that the intermediate layer (1) is made of refractory, heat-insulating material.

3. An element as claimed in claim 1 or claim 2 characterised in that it is in the form of a rigid panel (18).

4. An element as claimed in claim 1 or claim 2 characterised in that it is in the form of a flexible sheet (65).

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Fig.1

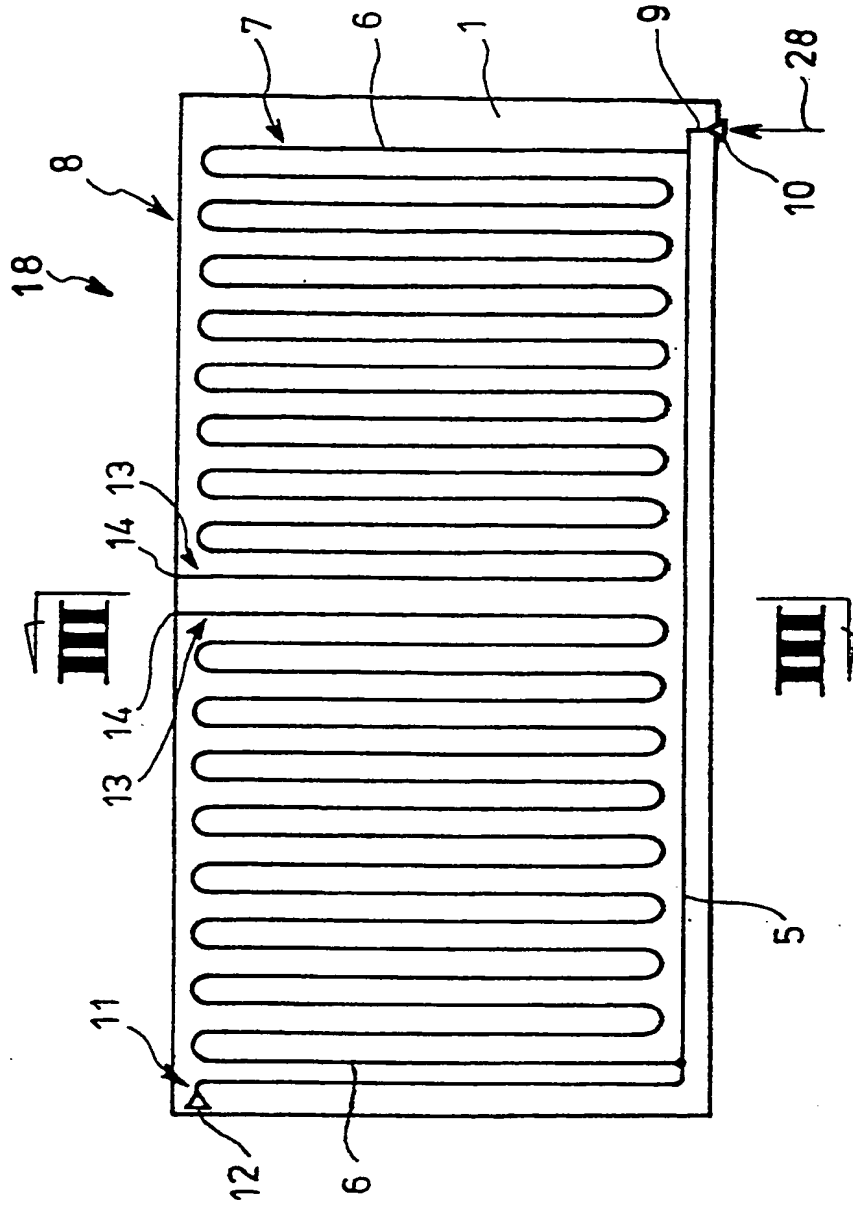
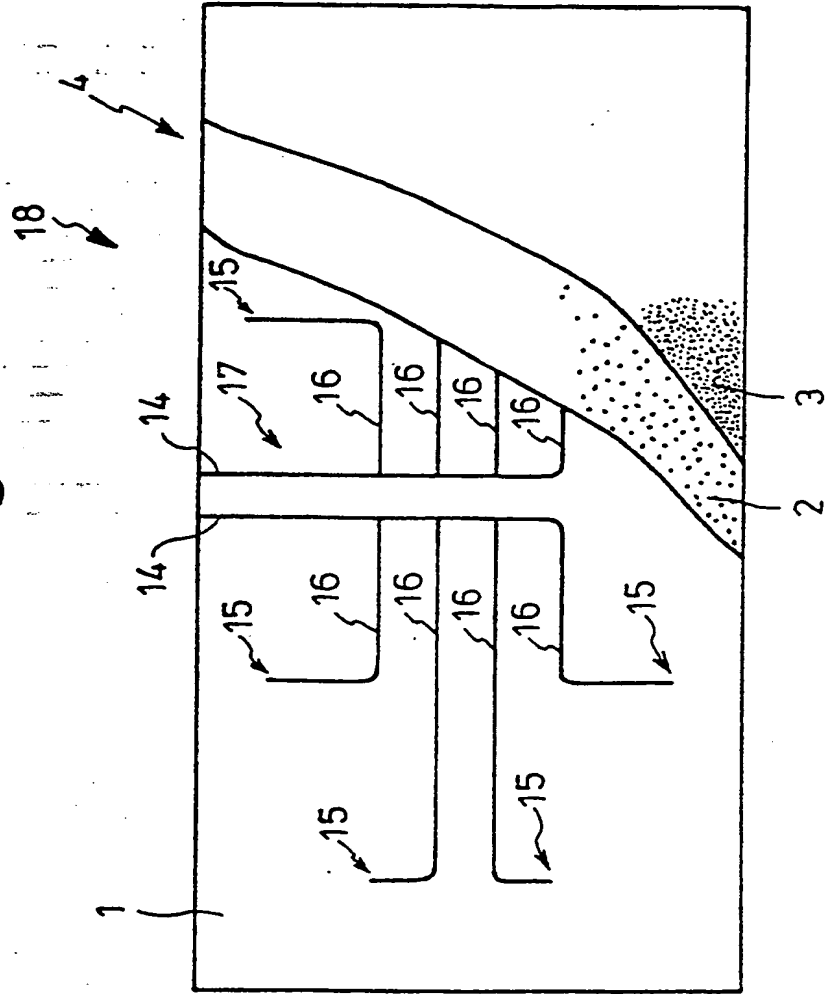


Fig. 2



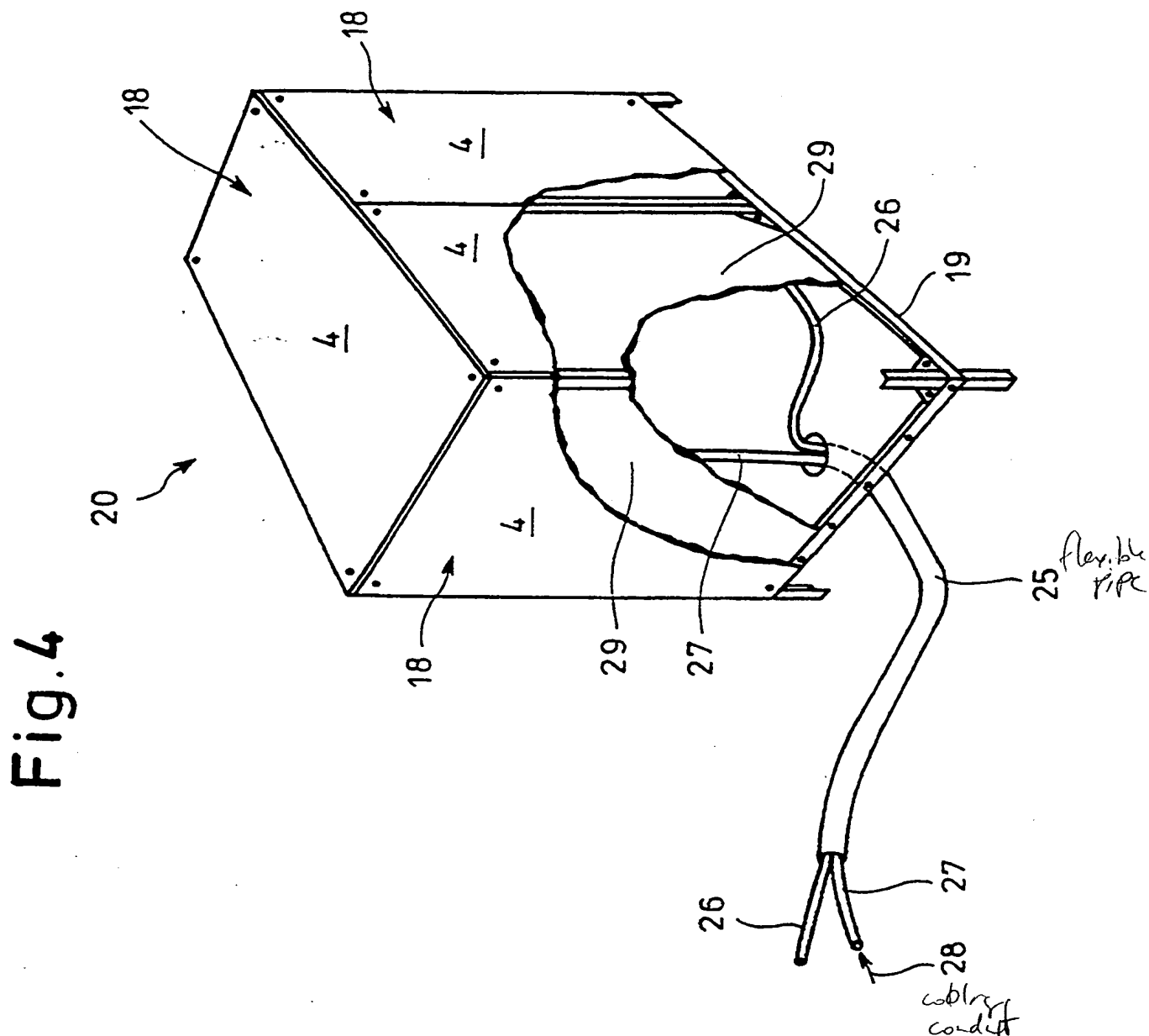


Fig.5

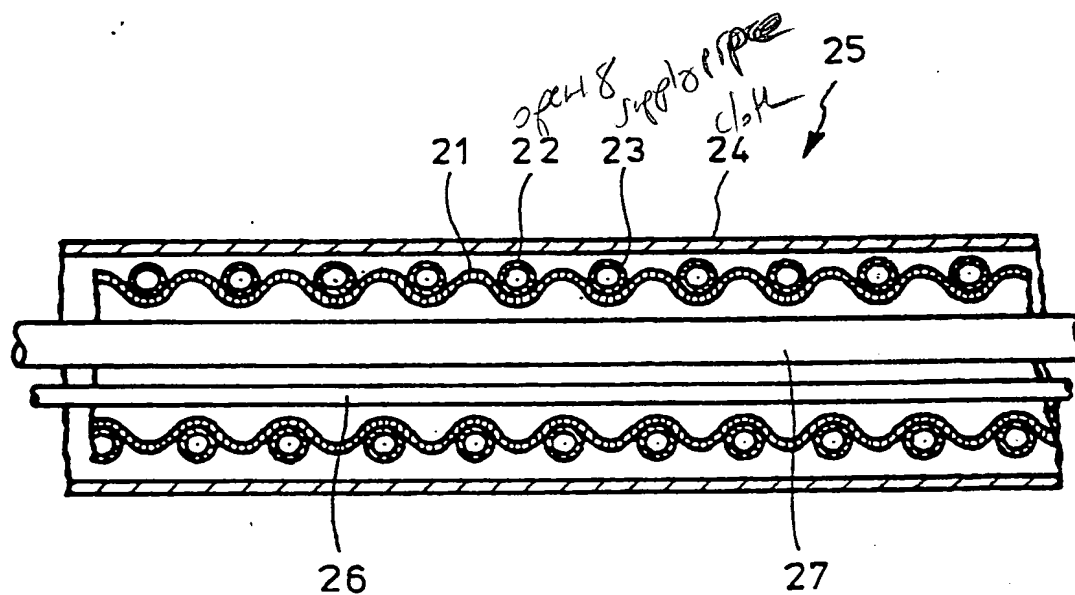


Fig. 6

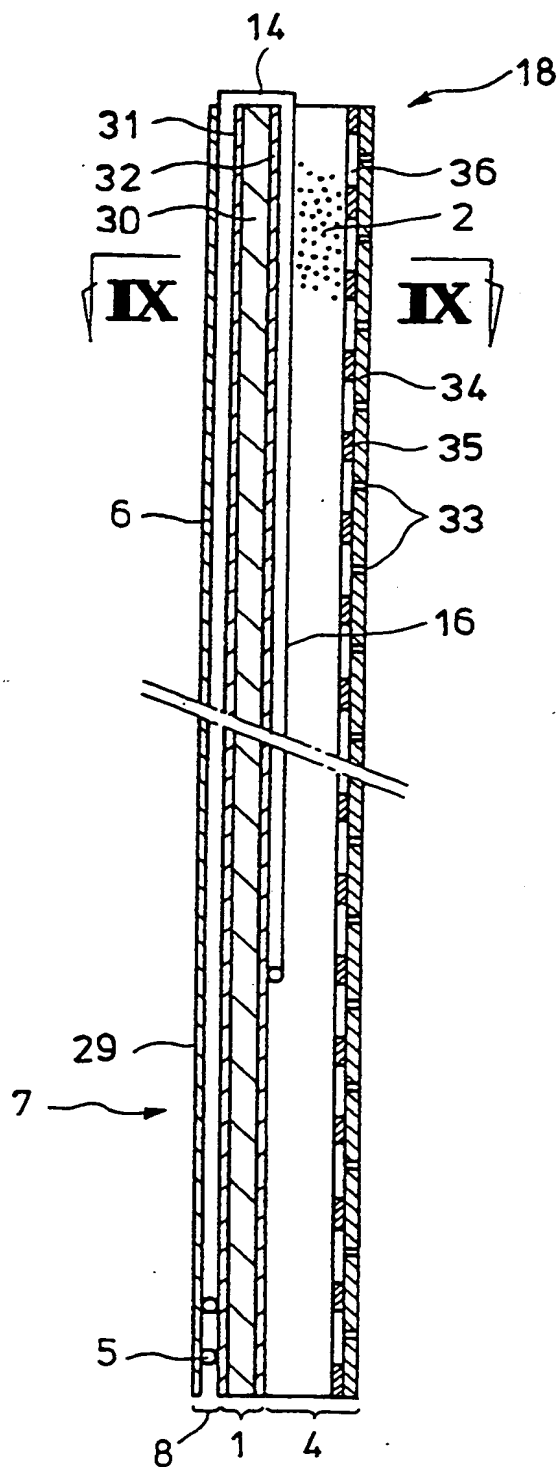


Fig. 7

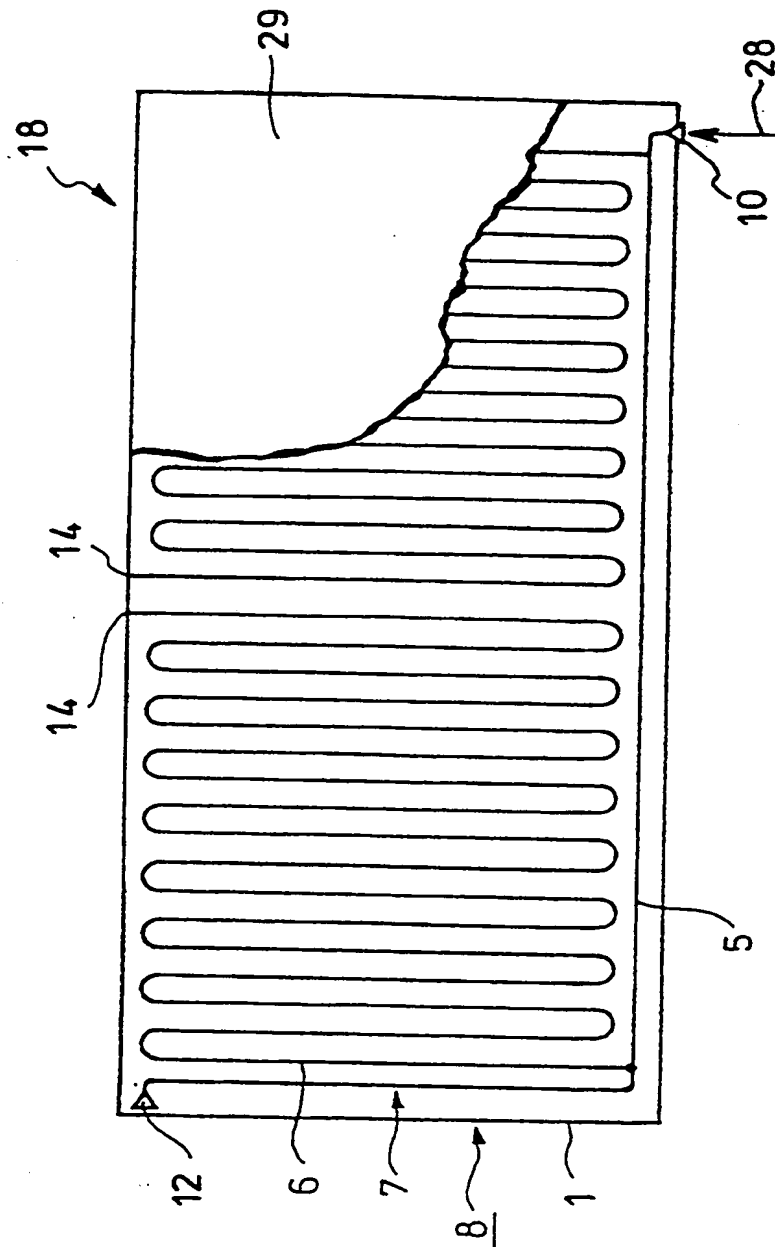


Fig. 8

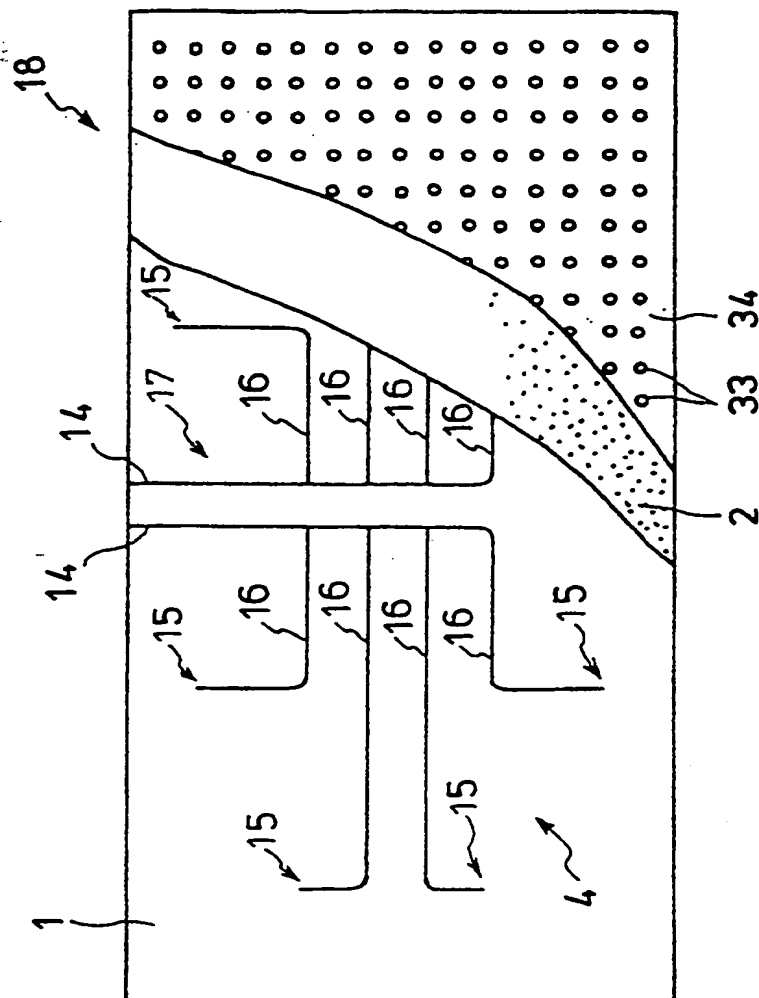


Fig. 9

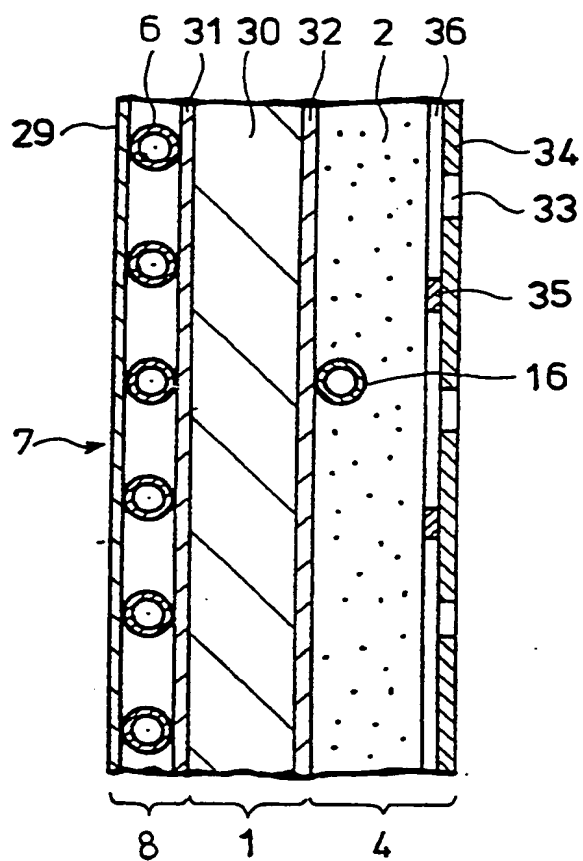


Fig.10

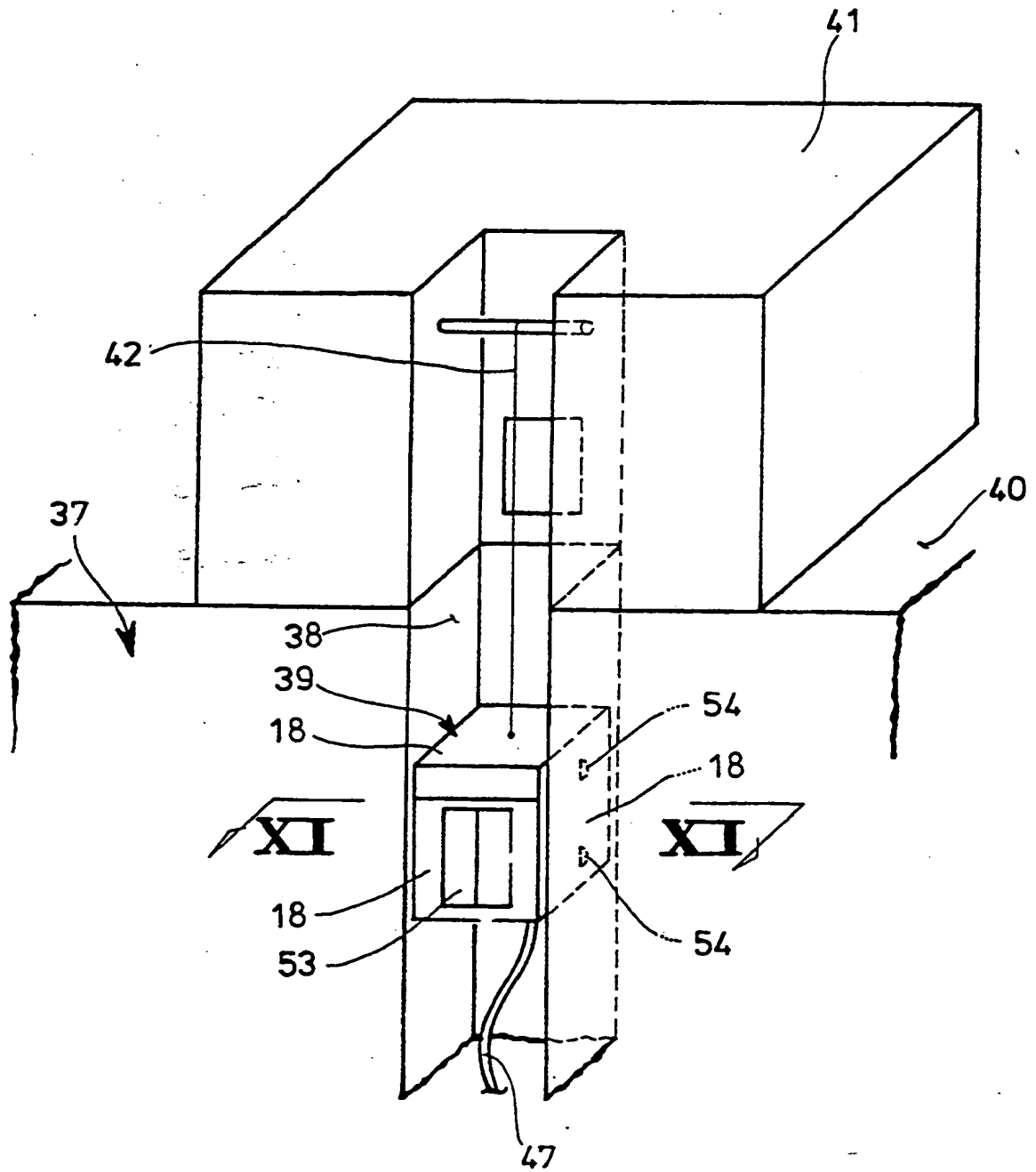


Fig.11

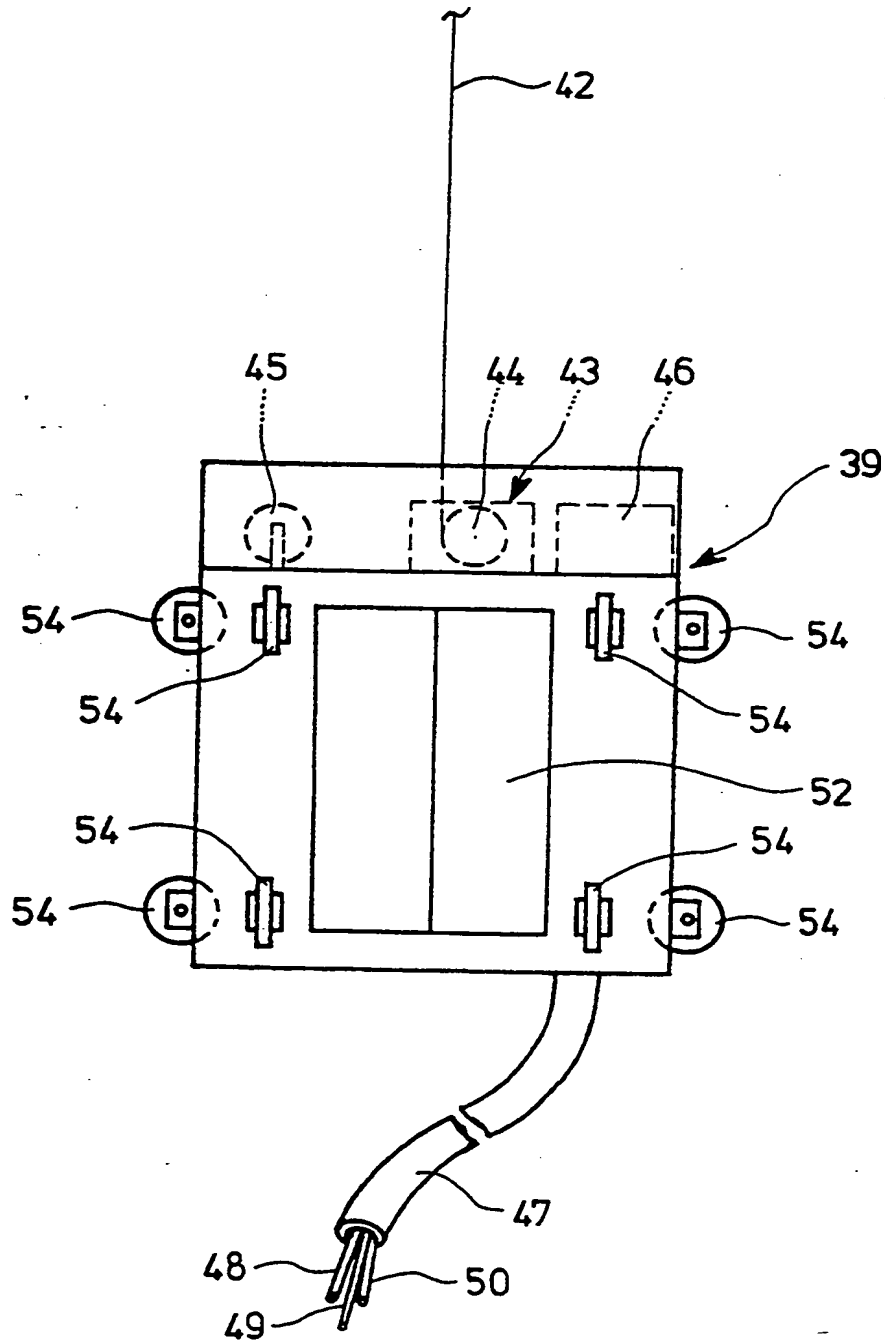


Fig.12

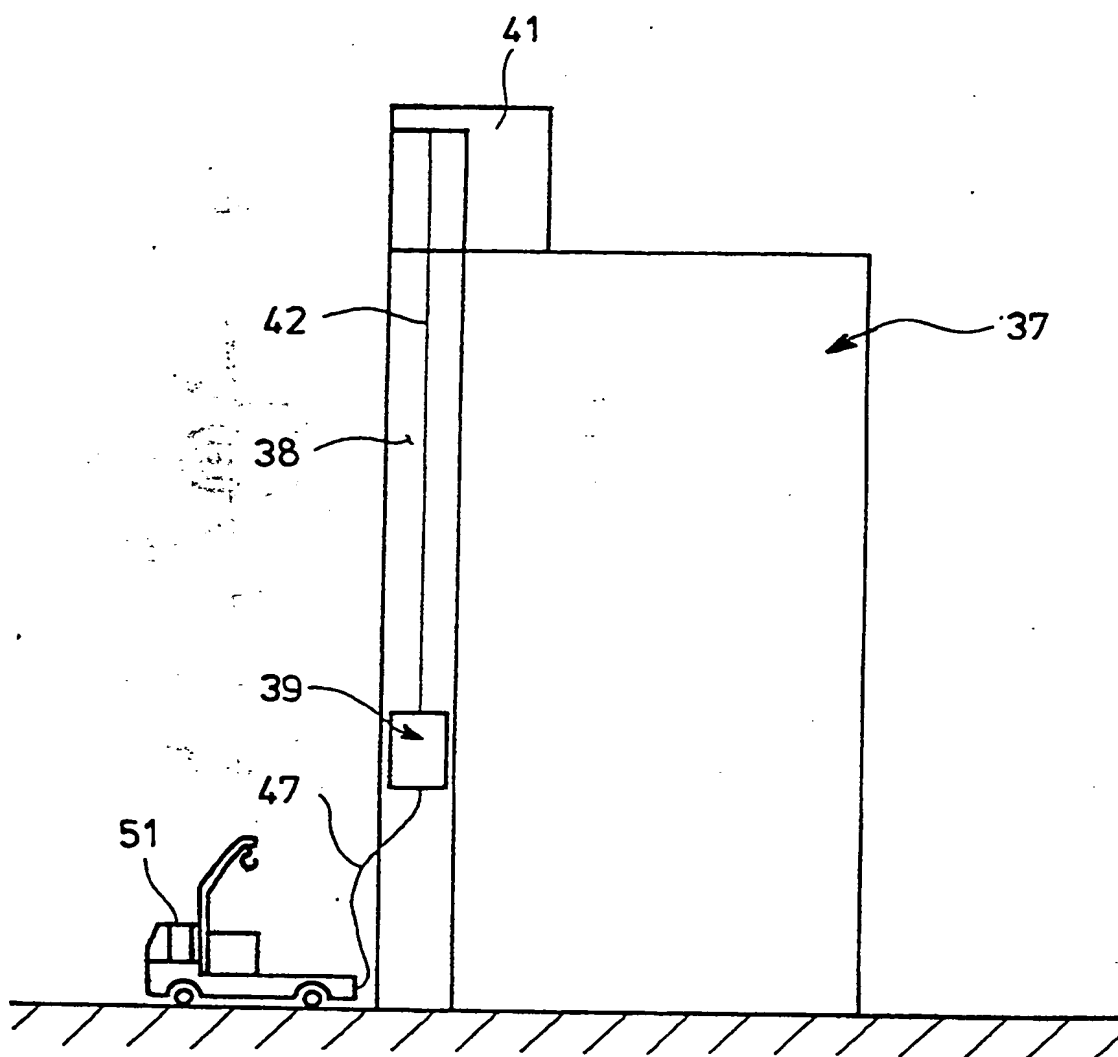


Fig.13

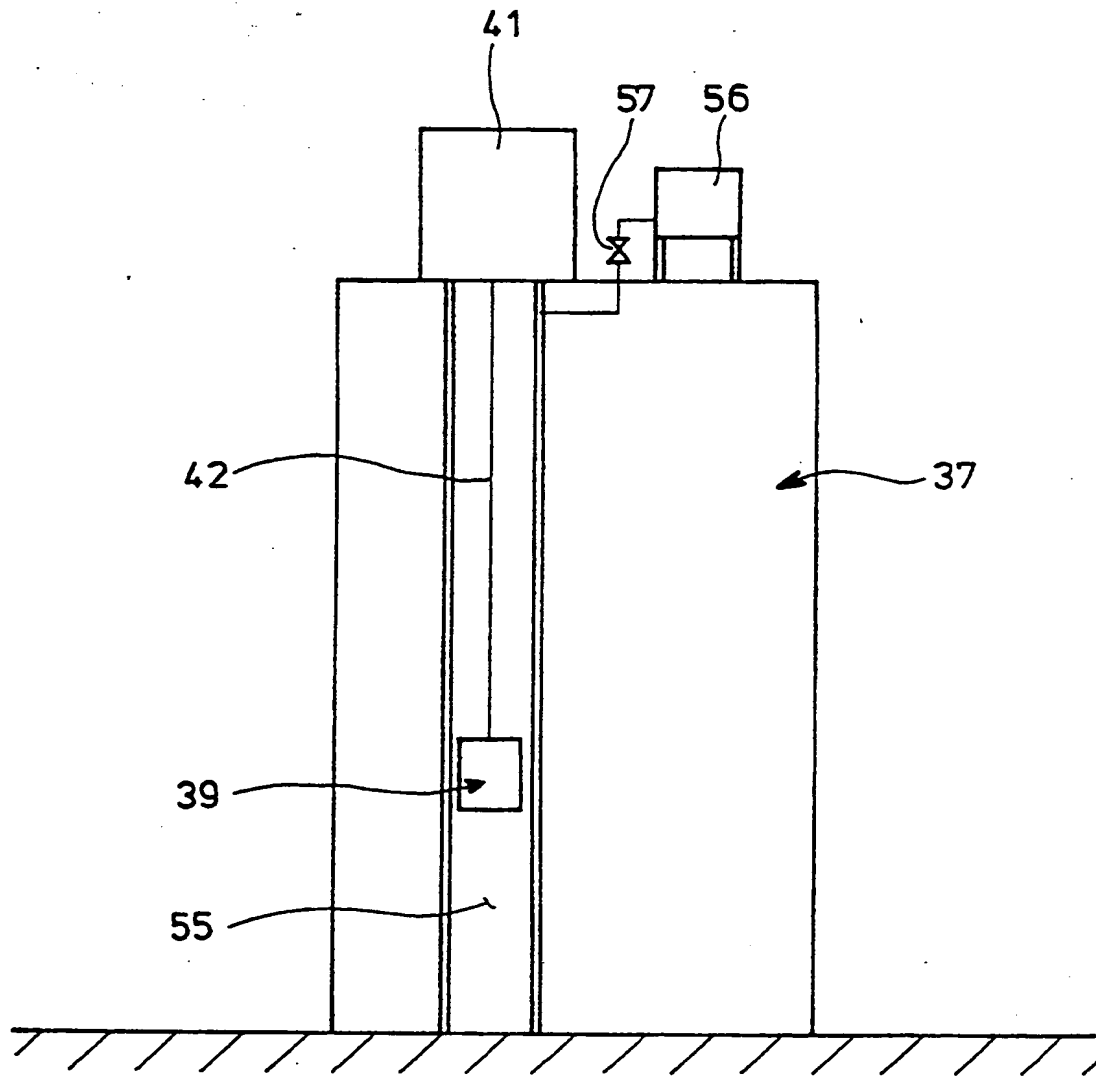


Fig.14

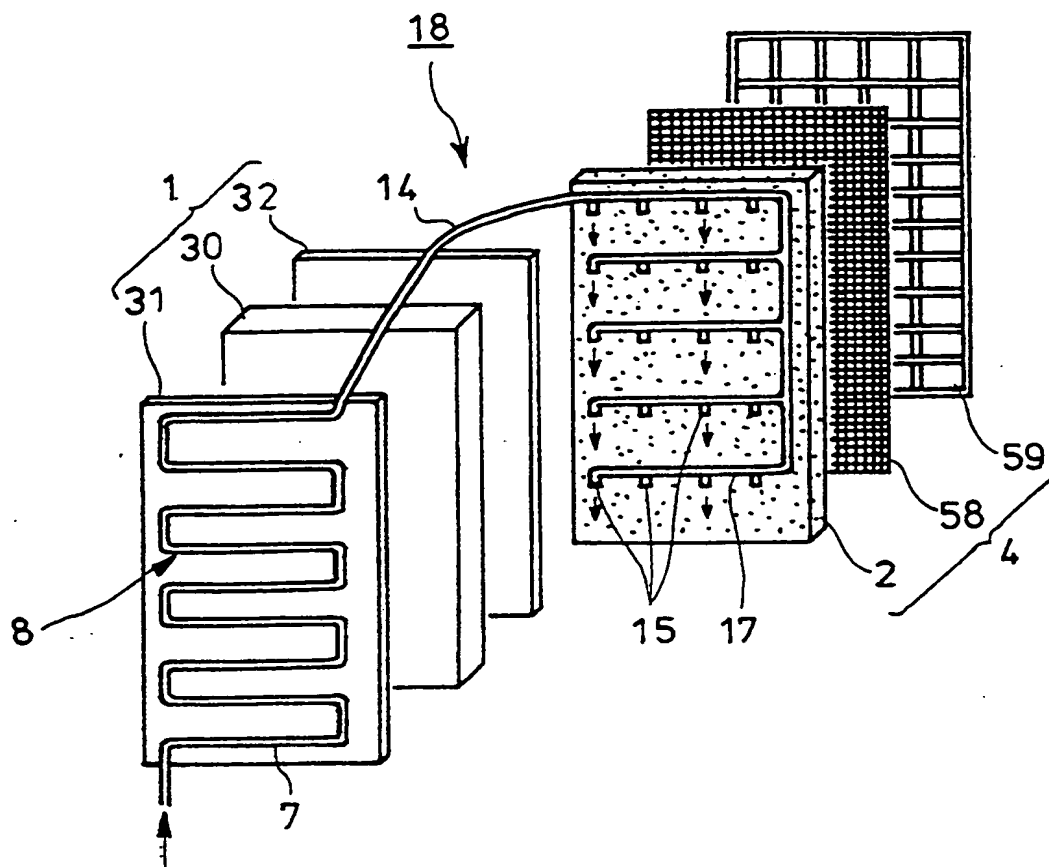


Fig.15

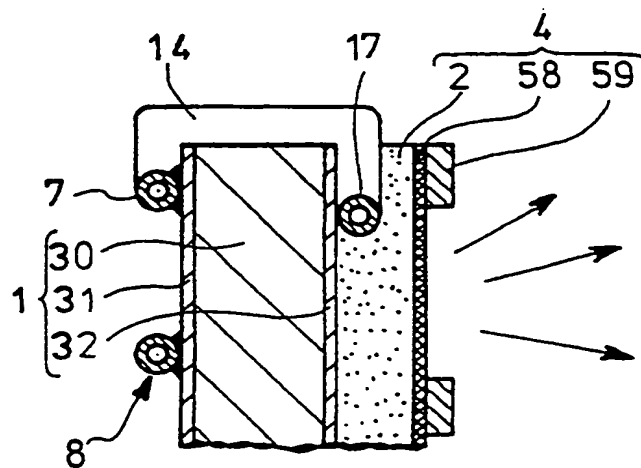


Fig.16

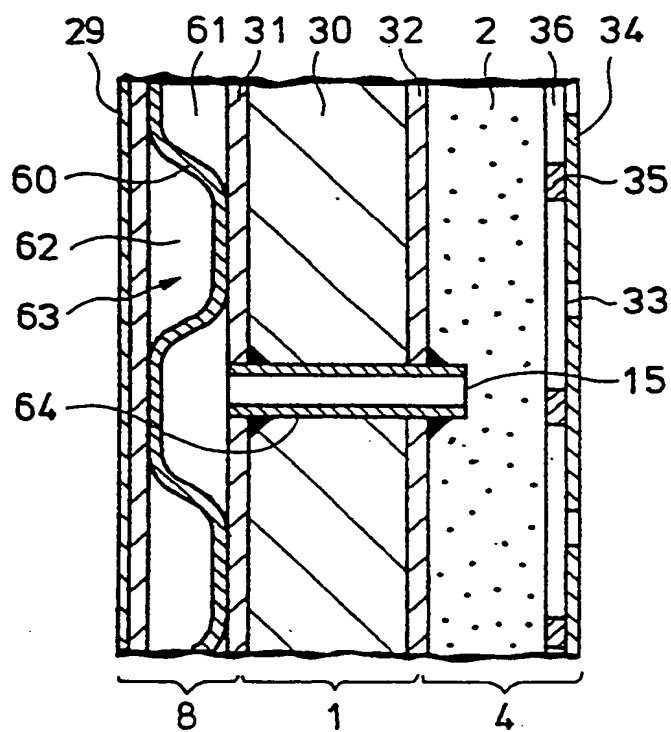


Fig.17

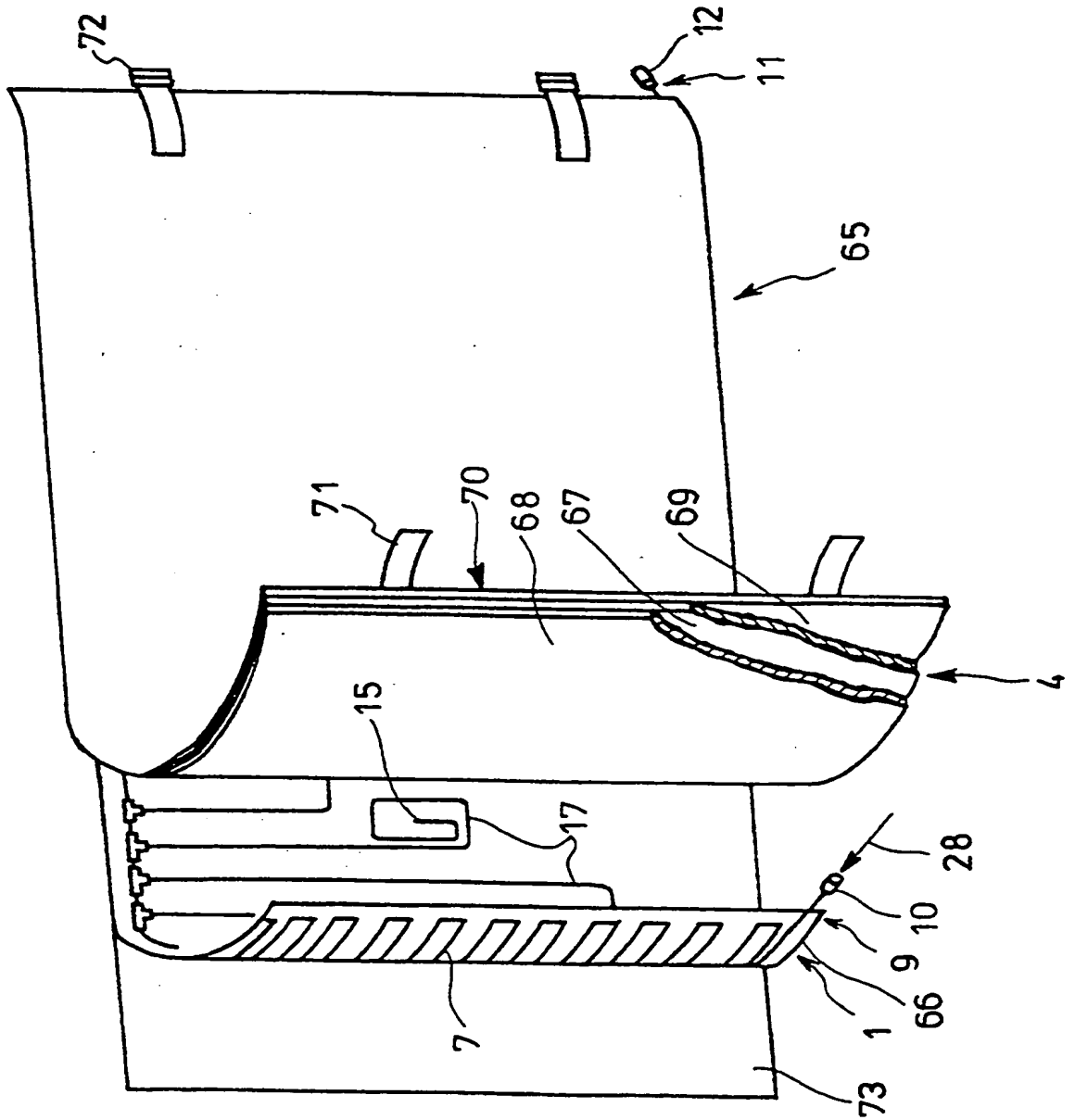


Fig.18

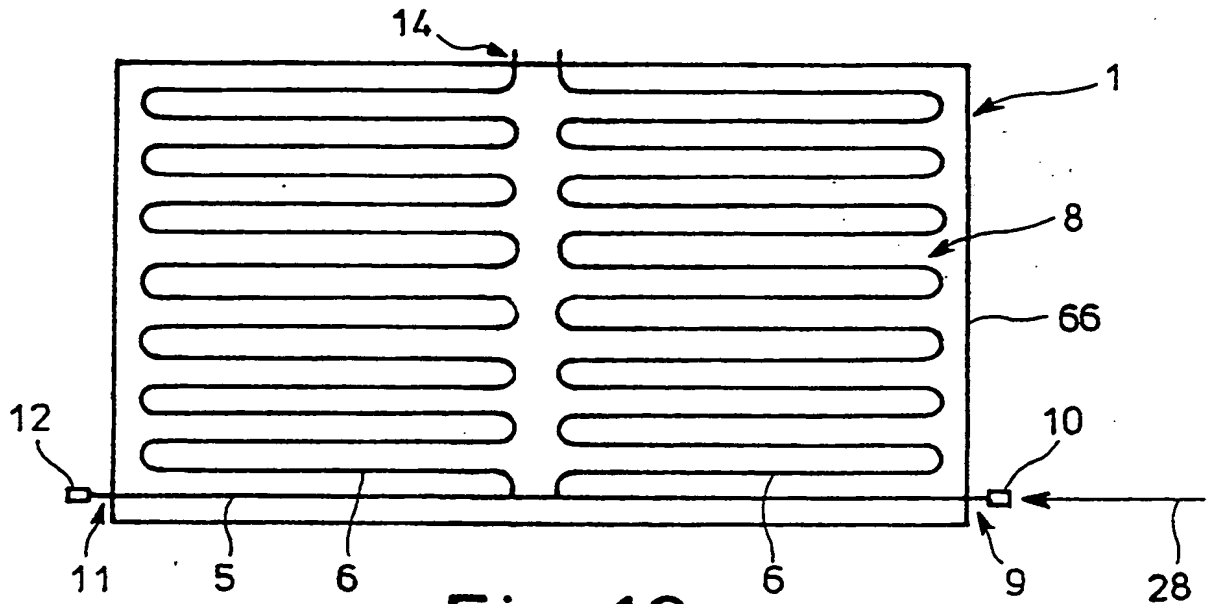


Fig.19

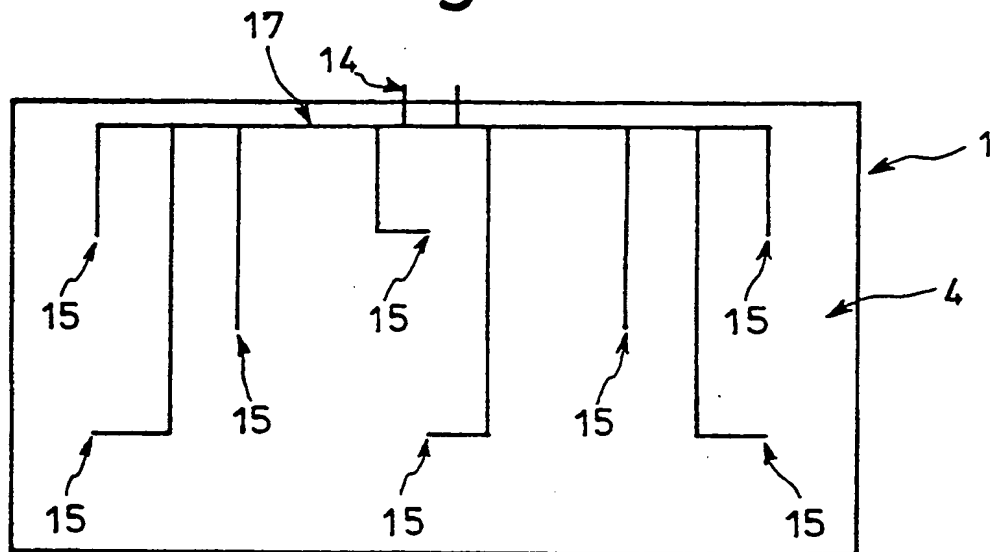


Fig.20

